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Improving Adherence to Cotrimoxazole for the Treatment of Childhood Pneumonia in Niger

Revised April 2003





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Improving Adherence to Cotrimoxazole for the Treatment of Childhood Pneumonia in Niger



Abstract

The development of antimicrobial resistance (AMR) has increased the worldwide threat of infectious disease. Strategies to curb such development include improving (a) patient counseling and (b) adherence to the antibiotic regimen. This study tested the effect of job aids for health workers and caretakers and training for health workers in interpersonal communication (IPC) on adherence to an antibiotic regimen for the treatment of childhood pneumonia in Niger (Edson et al. In press). Niger's IMCI (Integrated Management of Childhood Illnesses) policy stipulates that children with pneumonia should receive two doses of cotrimoxazole each day for five days; the dosage is half an adult pill for infants from three to 11 months and an entire adult pill for children one to five years old. Cotrimoxazole has to be stored out of reach of children and in a dry place, and it should be crushed and dissolved in clean water for administration to the child. In addition, the full course of pills must be fully consumed and the child should have a follow-up visit at the clinic. Broad adherence to the regimen is expected to reduce AMR.

We conducted a quasi-experimental study with a nonrandom assignment of eight clinics into either a program or control group. After training in IPC and the use of job

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Abstract Continued

aids, nurses in the four program clinics used the job aids—a counseling card, poster, and medication envelopes—while counseling the caretakers (usually mothers) of children with pneumonia. Nurses at the four control clinics initially received neither the training nor job aids but did so after the first round of data collection.

The study included 675 cases: 348 in the program and 327 in the control group. To measure nurses' medication counseling and IPC skills, we observed each nurse twice during the study. To measure caretaker adherence to the regimen, we visited caretakers' homes four or five days after the clinic visit and talked to the caretakers. We counted the remaining pills to be able to compare actual consumption against the nationally prescribed consumption. We also observed medication storage and administration to determine that aspect of adherence. Last, we asked caretakers about the factors that are believed to affect regimen adherence: caretakers' understanding of the regimen, their trust in the nurse, and their perception of the child's health.

We calculated "caretaker adherence" (percentage of pills that the caretaker received at the initial clinic visit that were given to the sick child) and "overall adherence" (percentage of sick children who received the five-day course of pills). After collecting data on both the program and control groups, we implemented the intervention in the four control clinics and measured nurse IPC in those clinics.

One nurse at each clinic participated: the one who treated the most cases of childhood pneumonia. All eight

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Improving Adherence to Cotrimoxazole for the Treatment of Childhood Pneumonia in Niger

Wendy Newcomer Edson, Maina Boucar, Sabou Djbrina, Ibrahima Mahamane, and Herbert W. Ware

Abbreviations

AMR	Antimicrobial resistance
ANOVA	Analysis of variance
ALRI	Acute lower respiratory tract infection(s)
ARI	Acute respiratory infection(s)
BASICS	Basic Support for Institutionalizing Childhood Survival
CFA	Niger's unit of currency
DHS	Demographic and Health Survey
HLM	Hierarchical linear modeling
IMCI	Integrated Management of Childhood Illnesses
IPC	Interpersonal communication
MICs	Minimum inhibitory concentrations
QA	Quality assurance
WHO	World Health Organization

1. Background

The development of antimicrobial resistance (AMR) has increased the worldwide threat of infectious disease. The World Health Organization (WHO) considers poor adherence to dosage regimens to be an important patient-related factor contributing to the problem of AMR (WHO 2001). Recent studies in Africa have documented AMR to *S. pneumoniae*, which causes pneumonia, a potentially fatal disease. In Kenya, 29 percent of *S. pneumoniae* isolates from invasive pediatric outpatient disease were found to be resistant to benzylpenicillin (minimum inhibitory concentrations [MICs] of > 0.1 microgram/ml) (Scott et al. 1998). *S. pneumoniae* resistance to penicillin in South Africa increased from 4.9 percent in 1979 to 14.4 percent in 1990, and resistance to cotrimoxazole was 44 percent (Koornhof et al. 1992). In Botswana, 50 percent of *S. pneumoniae* isolates from nasopharyngeal swabs were resistant to either penicillin or cotrimoxazole (Huebner et al. 1998).

A. Adherence to Antibiotic Therapy

Factors linked to the development of AMR include poor patient compliance with the prescribed drug treatment and overprescribing of

antibiotics. Strategies to address these factors include improving patient counseling to stress the importance of adherence to the antibiotic regimen. However, even when drugs are correctly prescribed and the patient/caretaker is carefully counseled, the patient/caretaker often forgets, prematurely discontinues, or interrupts the treatment regimen. This problem can be addressed through a combination of interventions: better communication and counseling of the patient/caretaker, involvement of family or community members in the provision of care, follow-up visits by community health workers, and job aids that help the patient/caretaker remember the regimen.

In developing countries the patient/caretaker's (hereafter caretaker; all patients in this study were five years old or younger) understanding of the role of modern medication and the importance of completing the entire course of treatment are key elements of strategies to ensure regimen adherence. In a study of compliance with antibiotic therapy for acute lower respiratory tract infection (ALRI) in Bangladesh, all children appeared to have been given the antibiotic, but a quarter were being underdosed (De Francisco and Chakraborty 1998). In Niger, a study found that caretakers knew the dose and frequency of the antibiotic regimen more often than the duration of treatment (DSNIS 2000).

Reasons for noncompliance with medication regimens are complex, but often include the caregiver's perception of the severity of the illness, his/her attitude toward the healthcare system, his/her perceived relationship with the healthcare provider, his/her trust in modern versus traditional medicine, and the type and appearance of the prescribed drug (Homedes and Ugalde 1994). A U.S. study found that trust in the provider may be better than satisfaction at indicating which patients remain with their physician and adhere to treatment recommendations (Hall et al. 2001).

B. Job Aids

Job aids provide reminders and information to individuals that support their work or activities. Examples of job aids for health workers include posters, instruction cards, flow charts, clinical algorithms, and critical pathways. Job aids for patients include medication packaging, child nutrition cards, diaries, and calendars. Among health workers, job aids can enhance performance, promote compliance with standards, and reduce costs of training and retraining (Knebel 2000). The Quality Assurance Project (QA Project) has developed and tested several job aids (e.g., a pre-eclampsia critical pathway in Uganda that helps hospital staff remember and document care, a poster depicting correct medication and dosage for malaria treatment in Kenya, and instructions on how to use a malaria diagnostic kit).

To enhance compliance with medication, research has explored medication packaging to remind patients of a drug's dosage and regimen (McMahon et al. 1997;

Ellison and Altemeier 1982; Ansah et al. 2001). A pictorial insert added to drug packaging for chloroquine syrup for children improved compliance in Nigeria (Okonkwo et al. 2001). Research testing visual literacy has found that pictures depicting frequency and duration of drug therapy can be misunderstood, underscoring the need to pre-test job aid prototypes to ensure correct comprehension of imagery (Nisal et al. 1997).

C. Study Setting

Data covering 1991 to 1998 in Niger indicate that of 198 *S. pneumoniae* isolates, 11 (5.6 percent) were insensitive to amoxicillin, but none were resistant. However, 16 of 186 isolates (8.6 percent) were resistant and an additional 12 (6.5 percent) were insensitive to cotrimoxazole (Dr. Djbo Saacou, personal communication, 4/27/00).

A 1998 DHS (Demographic and Health Survey) survey reported that 26 percent of infants in Niger less than three years old had had an episode of acute respiratory infection (ARI) in the previous two weeks (Attama et al.). The Boboye District of Niger reported 5,452 cases of pneumonia in children aged zero to five years during 1999 with most cases occurring from October through March (Boboye District Health Statistics 2000). The Niger Integrated Management of Childhood Illnesses (IMCI) guidelines for the treatment of pneumonia call for cotrimoxazole as the first-line drug and amoxicillin as the second. Neither pediatric suspensions nor pills were available in the district at the time of the study. The dosage for children one to five with adult pills is one pill two times a day for five days. The dosage for infants three to

11 months is half a pill twice a day for five days.

II. Purpose of the Study

The primary purpose of this study was to test the use of job aids in tandem with IPC training for nurses to enhance caretaker adherence to cotrimoxazole for the treatment of childhood pneumonia in the Boboye District of Niger. Intervention studies addressing drug use by patients are lacking (LeGrand et al. 1999), particularly in francophone Africa (Radyowijati and Haak 2001). This study addressed both of these issues by testing an intervention targeting caretaker adherence in Niger.

III. Research Questions

Research questions for the study focused on four areas: caretaker adherence to cotrimoxazole, health worker counseling of caretakers of children with pneumonia, household behavior relative to the dosage regimen, and caretaker knowledge of the regimen. Specific questions for each area were:

Adherence to cotrimoxazole

Did the job aids increase caretaker adherence to cotrimoxazole?

Did they make a difference in adherence in some clinics but not others? Why?

Did adherence vary if five days of pills were given rather than three?

Health worker counseling

Did the job aids improve the counseling nurses provided to caretakers?

What were the nurses' prescribing practices?

Household observations

Did the job aids increase the correct storage of medication?

Did they increase the return for follow-up appointments?

Did they increase the use of clean water with medication?

Were children in the study group healthier at the home visit?

Caretaker knowledge

Did the job aids increase caretaker knowledge of the antibiotic regimen?

IV. Description of the Job Aids

Using formative research, we developed appropriate messages and strategies for behavior change for health workers who treat children with pneumonia and for caretakers of those children (Edson et al. In press). The messages had been adapted from the national IMCI policy. We tailored use of the job aid for nurses to incorporate them into normal clinic operations: nurses could refer to them during consultations. Messages supporting adherence were conveyed using both text and images. A local artist had drawn the images (Figure 1) to reflect the culture. The nurse job aid consisted of a counseling card and a poster. The card had four images depicting how to (a) crush, (b) administer, and (c) store the antibiotic and (d) emphasizing consuming all pills over five days. The reverse of the card had text to prompt the nurse to inform the caretaker of correct regimen adherence. The poster had the same four images along with a

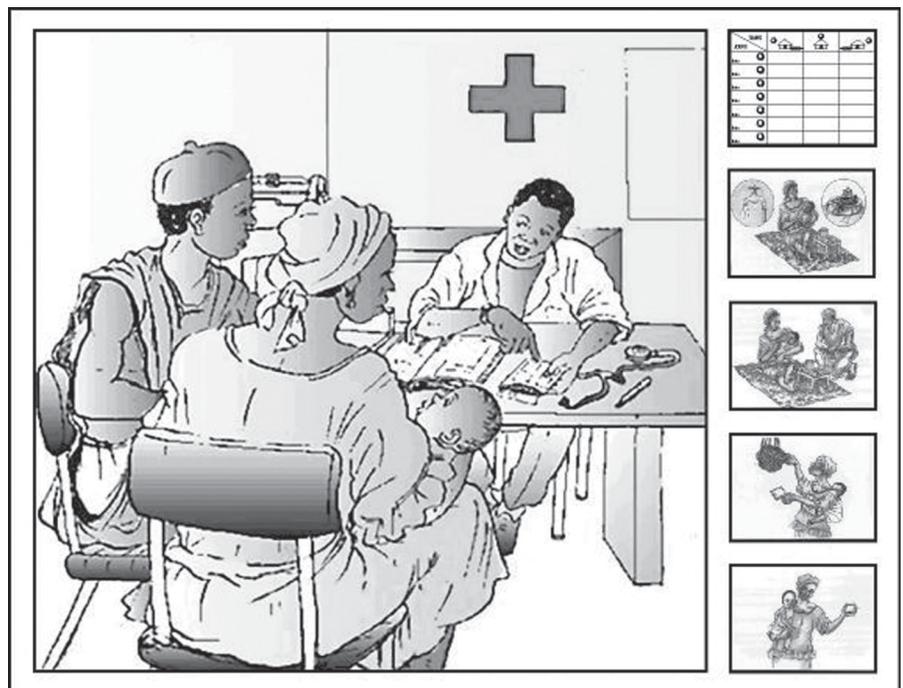
fifth depicting a health worker having a positive interaction with a family. Copies of the poster were placed in the consultation rooms.

Figure 1
Images for Job Aids for Health Workers and Caretakers



We also developed a medication envelope that health workers would give caretakers upon diagnosis of a child with pneumonia. Caretakers would take the envelope home with cotrimoxazole pills dispensed by the clinic. One side of the envelope had the first four images described above, and the other had images indicating the dose, frequency, and number of days the pills should be taken. At the completion of this phase, a fully developed, pre-tested set of job aids was ready for clinic use.

Next, we developed training materials with the assistance and guidance of the Director of Health Education for the Ministry of Public Health in Niger and the QA Project. Training introduced the job aids to the nurses and oriented them to IPC. Formative research had indicated a need for improved IPC



Artist: Mahamadou Nadéré

skills for health workers at the study sites. Simultaneously, the Regional Health Educator aired several local radio programs on ARI (which includes pneumonia) during the study period to increase community awareness of this illness. The broadcasts covered the district, focused on when to seek treatment for a child, and aimed to reach fathers (frequent radio listeners) in particular.

V. Methodology

A. Research Design

This quasi-experimental study had program and control groups and was conducted to test the effectiveness of the job aids and IPC training in increasing caretaker adherence to the cotrimoxazole regimen and in improving health worker counseling. We purposively selected the program and control groups, with each having four clinics to maximize similarity while minimizing cross-contamination through geographic dispersion. The program clinics and their health workers received the intervention (job aids and training in their use and in IPC) while the control group provided the usual care to patients without the intervention. Post-intervention data were collected in the program group on basic characteristics of the patients and households, IPC behaviors of the nurses, and caretaker adherence the regimen. At the same time, similar data were collected in the control group. Near the end of the study, the intervention was implemented in the control clinics. Data were collected in the control clinics on adherence and nurse IPC behaviors. Nurse behaviors in the post-training program group and

pre-training control group were compared to behaviors in the post-training control group.

B. Study Sample

Eight clinics in the district were matched on three key characteristics: number of ARI cases seen in previous year, number of health workers trained in IMCI, and geographic location (Table 1). Four clinics (program) were chosen north of the highway cutting through the district and four (control) to the south (Figure 2). The similarity of northern and southern sites was assumed a priori and later confirmed.

From these sites we identified two types of subjects: (1) caretakers of children with pneumonia and (2) the nurses who counseled them. We

included a caretaker if he/she presented with a child less than five years of age who was diagnosed with pneumonia, was treated with cotrimoxazole on an outpatient basis, and lived within a 10-kilometer radius of the clinic.

Each clinic had two health workers. The one who treated the most childhood pneumonia at each clinic participated in the study; all were nurses. Thus, the study included eight clinics and eight nurses. We gathered data on four nurse characteristics: in-service training, years of experience, languages spoken, and type of nurse (Table 2). Four had in-service training in both ARI and IPC skills. Some nurses had little experience while others had over 20 years. The languages spoken in the clinics were Haoussa (eight clinics), Djerma (seven), and Peul (two).

Table 1
Sampling Frame for Site Selection

	Number of ARI Cases per Year	Name of Clinic	Geographic Location	IMCI-Trained Health Workers (# Trained / Total #)	Study Group
Large Sites	2,357	Falmey	South	2 / 2	Control
	1,103	Yéni	North	0 / 2	Program
	1,159	Fabidji	South	0 / 2	Control
	1,274	Kiota	North	1 / 2	Program
Small Sites	744	Koygolo	North	2 / 2	Program
	598	Koissi	South	1 / 2	Control
	594	Harikanassou	North	1 / 2	Program
	561	Bellandé*	South	1 / 2	Control
	217	Tonkosaré*	South	2 / 2	Control

* Bellandé was flooded in December 2000, so study recruitment ceased there and began in Tonkosaré in February 2001

Figure 2
Map of Study Sites
in Boboye District



C. Dependent and Independent Variables

Adherence. Niger’s IMCI policy for treating pneumonia (one adult pill twice a day for five consecutive days [ten pills in all] for children over one year, and half a pill twice a day for five consecutive days [five pills in all] for infants from three to 11 months) gives both the nurse and

the caretaker a responsibility: the nurse must give the caretaker proper instructions and the correct number of pills, and the caretaker must have the child consume the pills according to the instructions. Three different indicators of adherence to the recommended regimen were defined and measured: nurse adherence (correct instructions and correct number of pills given to caretaker), caretaker adherence (pills received at initial visit¹ were given to the child on schedule), and overall adherence (child received the full, recommended course of pills). We did not measure the instructions or the exact times when pills were consumed; we measured only the number of pills given to the caretaker at the initial and later visits to the clinic and the number of pills consumed.

For example, if a caretaker received three days of pills at the initial visit and gave them all to the child by the home visit on day 4 but did not obtain additional pills, caretaker adherence would be 100 percent: all pills obtained at the initial visit were taken according to schedule. However, *overall adherence* would be zero because four days of pills should have been consumed by the home visit.

The primary dependent variable, “caretaker adherence,” was measured by a pill count at the home on the fourth or fifth day of therapy followed by asking the caretaker the reason for any observed discrepancy. Two measures were calculated with these data: (1) “proportion adhering exactly”: the proportion of caretakers who apparently adhered

Table 2
Nurse Characteristics by Clinic

Clinic	In-service Training	Years of Experience	Languages Spoken	Type of Nurse
Program				
1	ARI and IPC	23	Djerma, Haoussa and Peul	Technical Nurse
2	Diarrhea	0	Djerma and Haoussa	Technical Nurse
3	ARI and IPC	7	Djerma and Haoussa	Professional Nurse
4	Diarrhea	0	Haoussa	Professional Nurse
Control				
5	ARI and IPC	23	Djerma, Haoussa, and Peul	Technical Nurse
6	ARI and IPC	24	Djerma and Haoussa	Technical Nurse
7	IPC	24	Djerma and Haoussa	Professional Nurse
8	IMCI and IPC	2	Djerma and Haoussa	Professional Nurse

Notes: IMCI: Integrated Management of Childhood Illnesses. ARI: Acute respiratory infections. IPC: Interpersonal communication

¹ We wanted to measure caretaker ability to hold up her end of the bargain by giving the child all the pills received at the initial visit on schedule, without holding her responsible for instances when nurses dispensed less than the full course.

to the requirement that a half or whole pill be given twice a day for five days, and (2) “pill ratio”: a mean over all households of the ratio of pills used to the pills expected to have been used at the time of the home visit.² The pill ratio for each household was calculated by subtracting the number of doses observed (e.g., not consumed) from 10 doses and dividing the result by 10 minus the number of doses that should have been consumed. The pill ratio ranged from zero to 1.0: higher ratios indicate greater adherence. The “proportion adhering exactly” measure indicated the *proportion* of all caretakers adhering. The denominator included caretakers who had given either too much, too little, or exactly the correct number of pills. The “pill ratio” measure indicated the *degree* of adherence; its denominator included only those who gave exactly the correct number or too few. Six caretakers were excluded for having given too many pills. The pill ratio was used to determine the effect of the intervention on caretaker adherence.

“Overall adherence” integrates nurse adherence and caretaker adherence. This indicator was used to analyze the effect of giving five days of pills—rather than fewer—at the initial visit. Overall adherence was defined as the proportion of caretakers who, on the day of the home visit, had apparently given the child the correct number of doses as indicated by pill count. It required that (and means that) the caretaker obtained the correct number of pills whether or not at the initial visit. As a dichotomous variable in which the

number of pills consumed is exactly correct or else incorrect, it is similar to the “proportion adhering exactly” measure of caretaker adherence.

Caretaker knowledge. Intermediate outcomes, including caretaker knowledge of the antibiotic regimen, were measured during the home visit. The caretaker was asked about three aspects of the regimen: the number of pills, the number of times per day, and the number of days pills should be given to the child. We asked the caretaker if the follow-up appointment was kept to measure adherence to that aspect of the regimen. We asked to see all children’s medication kept in the home and observed where the medication was stored and what types of medication were present. Preparation of the medication before administration was also observed: the observer recorded how the pill was crushed, the type of liquid used for mixing, what utensil was used to give it to the child, whether part of the medicine was spilled, whether some of the medicine was not administered, and whether the caretaker verified that the child swallowed all of the medicine.

Health outcome. The child health outcome was measured by the caretaker’s perception of the child’s health at the time of the home visit. We asked the caretaker whether the child’s health had improved and, if so, had it improved completely or did the child still have a cough, a fever, or nasal discharge.

Trust in health worker. Caretaker trust of the health worker was measured by asking six questions derived from the Trust in Physician

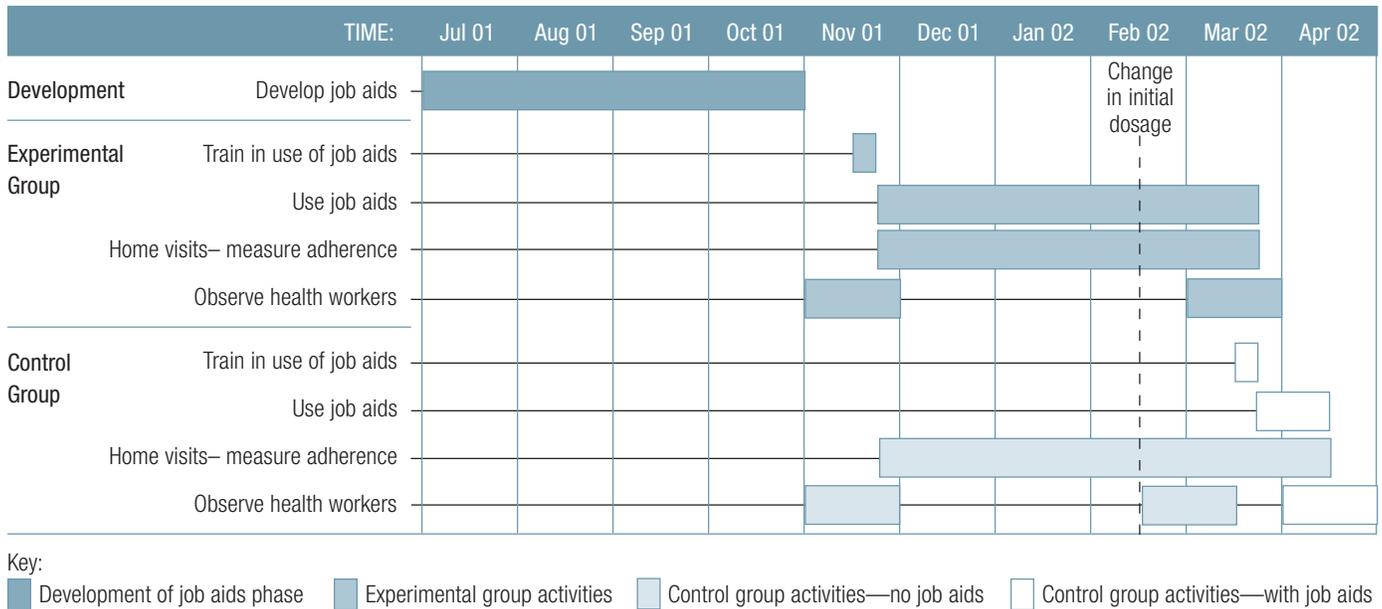
Scale, developed for use with U.S. populations (Thom et al. 1999). The questions were modified to fit the context in Niger and translated into the local language. The final question, a measure of overall trust, “Considering everything, do you have trust in the health worker that you saw?” was used in the analysis. Client satisfaction was measured by asking the caretaker if improvements were needed in the care at the clinic.

Nurse practice. The nurses’ practices were measured through periodic observations of their counseling skills by a supervisor from a neighboring district using a structured observation instrument. The supervisor rated nurses on their explanatory and IPC skills, including how they explained the regimen to the caretaker, whether they demonstrated administering the medication, and whether they verified the caretaker’s understanding of their counseling. In all, 23 different practices were measured: six related to verbal explanation, four to demonstration, six to verification, and seven to IPC skills. The average nurse counseling score for each of these areas was calculated for each study group, as discussed below in the Results section under “Counseling Skills.” The average nurse counseling score for each study group was obtained by calculating the mean score over all observed cases in each clinic.

Study group. There were two study groups: the program group and the control group. The program group received the job aids program near the beginning of the study, and the

² We assumed that one pill (or half pill in the case of an infant) should be taken on the day of the clinic visit when the pills were received, and each day thereafter one pill (or half pill) should be taken at breakfast and one at evening mealtime.

Figure 3
Timeline of Study Activities



control group received it near the end. Measurements of health worker practices were done before and after the introduction of the job aids program in each group, so it is important to specify whether it is the pre- or post-intervention measurement. Measurements of adherence during home visits occurred in both the program and control groups only after the introduction of the job aids in the program clinics. The timeframe is shown in Figure 3.

Child, caretaker, and household.

We measured the following child characteristics: child’s age in months, birth order, gender, relationship to head of household, and the caretaker’s relationship to the child. We measured the following caretaker characteristics: caretaker’s age, ethnic group, education, and marital status. For household characteristics we measured household size, whether there was a

radio or television in the household, whether the house had tap water, and distance from the clinic.

Clinic consultation. We measured the following clinic characteristics: money (in CFA francs) spent on medication for the visit, whether aspirin or chloroquin was prescribed, and the number of days between the clinic visit and the home visit.

Number of pills. We measured the number of days of cotrimoxazole pills prescribed/given to the caretaker at the initial visit (“initial dosage”), and the total number of days of pills prescribed/received at that visit and on any subsequent visits (“number of days received”).

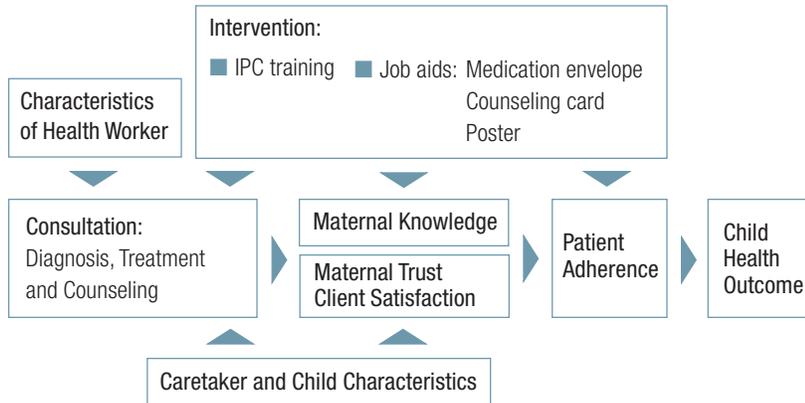
All variables were measured in both the program and control groups. Figure 4 displays the conceptual framework for the study.

D. Instruments

We developed or modified three instruments for the study: the first was used during the initial contact between study personnel and the caretaker at the clinic; the second for the home visit four or five days later; and the third for observing the nurses.

During the initial contact between the study personnel and the caretaker, information was collected on characteristics of the child, the current illness, prior visits for this illness, the diagnosis, medications given to the caretaker, whether the job aids were used during the consultation, and caretaker suggestions for improving care at the clinic. If the caretaker consented to a home visit, directions to the home were obtained and a date for the visit was arranged.

Figure 4
Conceptual Framework



The home visit instrument was an observation/interview tool to collect information on the characteristics of the caretaker and household: distance from the clinic, medications in the home including a pill count of cotrimoxazole, medication storage, and caretaker understanding of the regimen and the reason for cotrimoxazole. Each caretaker was observed preparing a dose of cotrimoxazole and administering it to the child if one was due. The observer also recorded the caretaker's perception of the health condition of the child and whether he or she had taken the child back for the follow-up appointment. In addition, the observer asked the caretaker six questions regarding overall trust in the health worker who had treated the child.

The Rapid Evaluation of Health Worker Performance instrument, developed earlier by BASICS as an observation tool for IMCI practices (BASICS I 2002), was revised for observing nurses during the study. We added questions on the use of the job aids and IPC. For example, we measured verbal explanations of

the dose and administration of the antibiotic and whether the nurse asked questions to ensure they were understood. The observer scored the nurse "Yes" or "No" on his or her performance of each item.

E. Data Collection Procedures

After training in the use of the job aids, the clinic staff at the program sites began using the job aids on November 19, 2001 (see Figure 3). Control site nurses received training on the job aids at the end of the study. Adherence to cotrimoxazole was measured during home visits throughout the study at program and control sites from late November through April, Niger's season for respiratory infections. We continued to measure adherence at the four control sites for one month after the control group nurses received training on the use of the job aids.

A local, female data collector was hired at each of the eight sites and trained in data collection. They were supervised weekly by the study

manager and assistant study manager. The local data collector approached all caretakers of children with pneumonia at each clinic to invite their participation in the research study. The data collector explained the study to the caretaker and obtained a verbal consent if he or she agreed to participate. A short verbal interview was then conducted to collect information on child characteristics and arrange a home visit.

On the fourth or fifth day after the clinic visit, the data collector visited caretakers in their homes and completed the observation/interview form. All caretakers were visited on the fourth or fifth day regardless of the number of pills dispensed at the initial visit. If a caretaker was not home, the data collector returned the following day. If the nurse gave only three or fewer days of pills and there were no pills remaining during the home visit, we asked the caretaker when the last pill was taken: this was compared to the time when all the pills should have been consumed. If the caretaker returned to the clinic and received additional pills at the end of three (or fewer) days, then the calculations were made using the additional pills received at that time.

At each clinic, a supervisor from the neighboring district observed the nurse at least twice during the study: the supervisors observed the program nurses in November and the following March and control group nurses in December and February and, after they had received training and job aids, in April.

Approvals to conduct the research study were obtained from the Division of Health Protection and

Health Facilities, Niger Ministry of Public Health; from USAID, Washington; and from the District and Regional Medical Directors. The study was reviewed by the local health committee in Boboye to ensure that it met local standards for ethics, culture, language, gender concerns and research procedures; the committee requested that all home visitors be female. Data were coded to protect the anonymity of study participants.

F. Data Analysis

Data were keyed into EPI INFO, and analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 9.0.

We compared the attributes of the program and control groups using chi-square tests, t-tests, and analyses of variance. A difference was judged significant if the probability of the t, F, or chi-square value was less than .05.

To assess the effect of the job aids on caretaker adherence, we used analyses of variance (ANOVA) to compare the mean pill ratio of the program group with the control group's using a Tukey *post hoc* multiple comparison procedure. The ANOVA were conducted using the pill ratio.

To assess the effect of the individual clinic on caretaker adherence we used an ANOVA in which we treated clinics as nested in the two treatment levels (program and control) and crossed with the number of days of treatment. An effect was judged significant if the probability of the F value was less than .05. In the final analysis six cases were excluded where the caretaker had given more medication than ex-

pected. To assess the interaction of type of nurse on caretaker adherence, we used a multifactorial ANOVA design crossing study group with type of nurse.

We used hierarchical linear modeling (HLM) to verify the impact of the clinic and its attributes on caretaker adherence. The unconditional or null model was initially specified. Level 1 was the caretaker and Level 2 was the clinic. In the first model the study group variable was introduced, and a Level 2 model in which study group as an attribute of the clinic was compared to the null model.

We compared the behaviors of nurses in the program and control groups by developing facility-level averages for the eight clinics of the proportion of nurses who were scored with a "Yes" on an item. Using the facility-level average, we compared the program clinics to the control clinics and the control clinics before and after their training using t-tests. A difference was judged significant if the probability of the t value was less than .05.

We assessed the effect of initial dosage on overall adherence using a chi-square test. Multi-variate analysis was not used in analyzing overall adherence.

VI. Results

A. Sample of Caretakers

There were 1083 caretaker visits for children with pneumonia at the eight clinics. Of those, 283 (26 percent) were excluded as they lived too far away from the clinic for a home visit. Of the remaining 800 caretakers, 22 (3 percent) declined participation in the study, 29 (3 percent) were not at home for the home visit, and the

remaining 749 (94 percent) were visited in their home.

Of the 749 home visits, 5 were excluded because the child did not receive cotrimoxazole treatment. Of the remaining 744, 677 (348 in the program group and 329 in the control group) were visited before the control group sites were trained in the use of the job aids. The remaining 67 home visits were conducted after the control site nurses had been trained in the use of the job aids.

The mean number of caretakers visited in their home by clinic site was 85, with a range from 75 to 98. The resultant sample sizes, by clinic are displayed in Table 3.

Table 3
Sample Size by Site

Site	Number of Caretakers Visited in Home	Number of Caretakers Visited after Control Sites Trained
Program		
1	94	N/A
2	98	N/A
3	78	N/A
4	78	N/A
SubTotal: Program	348	N/A
Control		
5	78	12
6	75	15
7	92	25
8	84	15
SubTotal: Control	329	67
Total	677	67

N/A: Not applicable

B. Sample Characteristics by Study Group

To determine the similarity of the program and control groups, we compared them on several factors:

characteristics of the child (age, birth order, gender, relationship to head of household, if caretaker was mother); of the caretaker (age, educational level, marital status,

ethnic group, trust in health worker); of the household (size; availability of radio, television, and tap water; distance from the clinic); and of the clinic consultation (cost of medication, medications received, day of home visit). The results are summarized in Table 4.

Table 4
Comparison of Program and Control Groups

Characteristic	Program Group N = 348	Control Group N = 329	Level of Significance
Child's characteristics			
Age (mean)	18.2 mos	18.2 mos	NS
Birth order (mean)	3.7	3.4	NS
Sex (% male)	54%	50%	NS
Child's relationship to head of household (% son or daughter)	83%	90%	.03
Caretaker was mother (% yes)	94%	92%	NS
Caretaker's characteristics			
Age	27.9 yrs	27.1 yrs	NS
Educational level			
% with no schooling	67%	78%	
% some Koranic school	16%	12%	.002
% some primary school	12%	9%	
% some secondary school	5%	1%	
Marital status (% married)	96%	97%	NS
Ethnic group			
% Peul	6%	18%	
% Djerma	89%	73%	< .001
% Haoussa	1%	7%	
Household characteristics			
Size of household	9.3 persons	7.4 persons	< .001
Radio in household (% yes)	68%	44%	< .001
Television in household (% yes)	1%	2%	NS
Tap water in household (% yes)	0.3%	12%	< .001
Distance from clinic (kilometers)	2.3	2.9	< .001
Clinic consultation			
CFA* spent on medication	287	315	.005
Day of home visit after consultation (mean)	4.2	4.6	< .001
Aspirin prescribed (% yes)	36%	49%	< .001
Chloroquin prescribed (% yes)	93%	63%	< .001

* CFA 725 = U.S. \$1 (4/02)

There were no significant differences between the program and control groups for the child's or the caretaker's characteristics except for ethnic group, caretaker's educational level, and child's tie to head of household. More Peul women were in the control group, more caretakers in the program group had some schooling, and more children were the children of the head of household in the control group. Household characteristics and characteristics of the clinic visit did differ significantly. Control group households were further from the clinic (2.9 versus 2.3 km) but smaller than program households (7.4 versus 9.3 persons). Program households had more radios (68 versus 44 percent), but fewer had tap water (0.3 percent versus 12 percent).

In addition to cotrimoxazole, more children were prescribed aspirin in the control group (49 percent versus 36 percent); however, more children were prescribed chloroquine in the program group (93 percent versus 63 percent). Medication cost slightly more on average for the control group (315 versus 287 CFA). The control group was visited in the home an average of 4.6 days after the consultation compared to 4.2 days for the program group.

C. Cotrimoxazole Prescribing Practices

We discovered early in the study that the clinics were dispensing

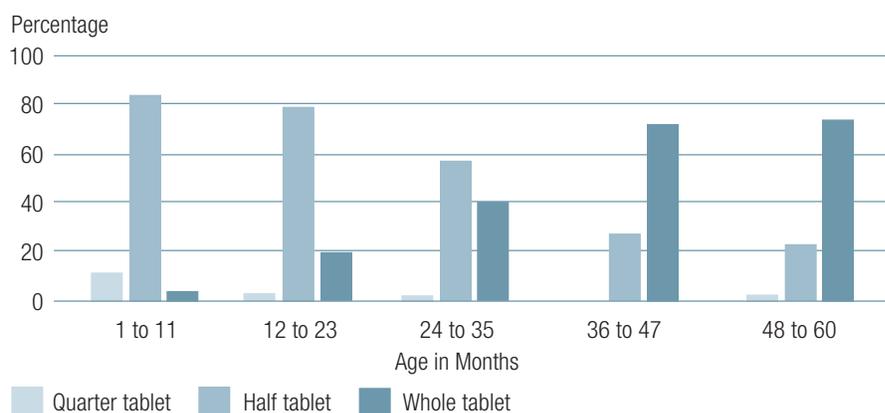
three days of treatment instead of the recommended five at the initial visit. Most caretakers were being asked to return to the clinic after three days for the remaining two days of pills; in one program clinic, caretakers who lived close to the clinic were asked to return daily for their medication. The nurses misunderstood the national policy to give the full five-day course at the initial visit and/or believed that there was not enough cotrimoxazole in stock to give five days to each child. We organized a supervisory visit in mid-February 2001 in order to distribute extra stocks of cotrimoxazole at all study sites and have the Ministry of Health supervisor clarify the national policy. After February 19, 2001, all children were given the full five days of treatment at the initial visit. Table 5 shows that the average initial dosage was significantly lower in the program group than in the control group before February 19 (2.7 versus 3.7 days of pills per initial visit), but after February 19 there was no appreciable difference between the two study groups (4.5 versus 4.6 pills per initial visit). The initial dosage was lower in the program group before February 19 as it included the clinic requiring patients to return daily.

Another study finding was that many children were not being correctly dosed according to their age (See Figure 5): infants between three and 11 months should have received half an adult pill twice a day and children from one to five should have received one adult pill twice a day. (There were no pediatric tablets in stock.) We were unable to calculate dosage according to weight, as we had not collected weight data.

Table 5
Cotrimoxazole Received at First Visit by Study Group

Average number of days of pills given at first visit	Program Group N = 348	Control Group N = 327	Level of Significance
Before February 19, 2001	2.7	3.7	<.001
After February 19, 2001	4.5	4.6	NS

Figure 5
Cotrimoxazole Dosage Prescribed Twice a Day by Child's Age during Study Period (December to April, 2001 [N = 739])



D. Counseling Skills

The results of the observation of nurses by a supervisor from the neighboring district appear in Table 6. Table 6 entries represent the mean of clinic averages for the program and control groups for each behavior. The first two columns show the difference between the program group (post-training) and the control group (pre-training) for each behavior. After the end of data collection in April 2001, the control nurses took the same training in the use of the job aids and in IPC that the program group had received earlier. These nurses ("post-training control nurses") were then observed during consultations by the same supervisor who had conducted the

observations of the program group members in February and March. The last column in Table 6 gives their post-training scores.

None of the differences in data in the three columns in Table 6 was significant due to the small sample sizes. There is wide variability in performance among the behaviors; for example, explanation, demonstration, and verification of dosage and times per day were done far more often than crushing and mixing. Table 6 groups the individual behaviors into four general behaviors (explanation, demonstration, verification, IPC). Nurses in the program group demonstrated the administration of the medication more consistently than those in the

Table 6
**Percentage Who Scored “Yes” for Behaviors Explaining the
 Antibiotic and IPC, by Program and Control Groups
 before and after Training**

Behavior	Program Mar 2001 Post-Training (Clinics = 4)	Control Feb 2001 Pre-Training (Clinics = 4)	Control Apr 2001 Post-Training (Clinics = 4)
Explanation items			
1. Verbal explanation of dose	100	99	100
2. Verbal explanation of # of times per day	100	99	100
3. Verbal explanation of crushing	23	12	50
4. Verbal explanation of mixing	50	17	75
5. Verbal explanation of number of days	77	96	98
6. Explain when to return for follow-up appt.	54	81	83
Average of verbal explanation scores	67.3	67.3	84.3
Demonstration items			
7. Demonstration of dose	50	17	72
8. Demonstration of # of times per day	50	7	72
9. Demonstration of crushing	25	3	29
10. Demonstration of mixing	50	3	49
Average of demonstration scores	43.8	7.5	55.5
Verification items			
11. Verify understanding of dose	50	74	80
12. Verify understanding of # of times per day	50	73	79
13. Verify understanding of crushing	23	14	29
14. Verify understanding of mixing	50	15	43
15. Verify understanding of number of days	50	70	55
16. Verify that mother knows when to come back for follow-up appt.	50	47	72
Average of verification scores	45.5	48.8	59.7
IPC Items			
17. Asks open questions	58	93	84
18. Asks understandable questions	87	94	89
19. Has a positive attitude	76	75	87
20. Asks open questions to make sure mother has understood	50	37	72
21. Corrects mother's errors or congratulates her	48	36	63
22. Asks mother if she has questions	25	5	36
23. No language problem	85	58	83
Average of IPC items	61.3	56.9	73.4

pre-training control group, but did not consistently out-perform the pre-training control group on behaviors related to explanation, verification, or IPC. The post-training control group did better than both the program and pre-training control group in all four categories of behaviors.

No changes were seen in several behaviors relating to explaining the antibiotic and verifying caretaker comprehension (Items 1, 2, 5, 10, 11, and 15). Increases occurred in all other “Explanation” behaviors, especially demonstrating the dose. A decrease occurred in “Verify understanding of number of days.” Increases occurred in all IPC behaviors except for three items (Items 17, 18, and 19), where no changes were seen.

E. Household Practice, Caretaker Knowledge, and the Health of Children

Using data from the home visits, we compared the program and pre-training control groups on household practices related to several aspects of household practices and caretaker understanding. These comparisons, made in terms of percentage of caretakers for whom they were observed, are displayed in Table 7.

In all but one of the significant differences—number of times per day—the group using the job aids had the more favorable outcome. The program group's average was pulled down by clinic 1, where only 74 percent of caretakers understood this aspect of the regimen. At all other clinics, control and program, 98 percent understood this aspect of the dosage.

F. Satisfaction and Trust

The control group was more satisfied with the care they received and more trusting of the provider than the program group. Satisfaction is thought to be a component of trust, so their correlation within the two

study groups would be expected. Caretakers in the program group stated that improvements in care were needed at the clinic more often than did caretakers in the control group (75 percent versus 42 percent: see Table 8). This differ-

ence in opinion regarding such improvements may be attributed to the more settled and more modern infrastructure of the program groups' villages.

In response to the question "Considering everything, do you have trust in the health worker you saw," most respondents answered "yes, completely," and 7.3 percent answered "yes, often." A comparison of the study groups found that 97 percent of the control group responded "yes, completely," compared to 89 percent of the program group (chi-square = 16.8, $p < .001$).

Table 7
Differences between the Program and Control Group for Keeping Follow-up Appointment, Maternal Knowledge, Child's Health, and Medication Storage and Preparation

	Program Group	Control Group	Level of Significance
Kept follow-up appointment (% yes)	79%	58%	< .001
Maternal knowledge (% correct)			
Number of pills	99%	99%	NS
Number of times per day	93%	97%	.01
Number of days	99%	98%	NS
Child's health (caretaker's perception, % yes)			
Improved completely	47%	35%	.002
Still has a cough	38%	46%	.03
Still has a fever	13%	25%	< .001
Still has nasal discharge	28%	42%	< .001
Medication storage* (% correct)	91%	87%	.04
Used clean water to mix medication (% correct)	94%	73%	< .001

* Stored out of the reach of children and in a dry place

G. Caretaker Adherence

Our primary interest was whether the job aids produced better caretaker adherence to the regimen, and an initial comparison of caretaker adherence in the program group and control group suggested that the job aids did improve adherence. The proportion of caretakers adhering exactly to the recommended regimen³ was 90 percent in the program group and 76 percent in the control (chi-square = [1,676] 22.152, $p < .001$). The mean pill ratio⁴ was 0.98 in the program group and 0.93 in the control ($p < .001$).

However, this result was modified when other factors were included in the analysis. The effect of the program on caretaker adherence was highly influenced by other factors, including the effects of individual clinics, type of nurse, and initial dosage. When the confounding effects of these factors were

Table 8
Description of Differences in Program and Control Group for Satisfaction with the Clinic Visit and Overall Trust in the Nurse

	Program Group	Control Group	Level of Significance
Caretaker stated improvements were needed in clinic (% yes)	75%	42%	< .001
Overall trust in provider (% yes, completely)	89%	97%	< .001

³ A caretaker adhered to the regimen if the number of pills consumed by the day of the home visit (actual consumption) was equal to the number of pills that should have been consumed (expected consumption).

⁴ Pill ratio is the ratio of actual pills used to expected pill use. This measure was taken during the home visit on the fourth or fifth day after the clinic visit at which the caretaker received the medication.

analyzed using multi-variate models, the principal finding was that the job aids program significantly improved caretaker adherence in clinics staffed by technical nurses, but in clinics staffed by professional nurses, the improvement in adherence was very small and not statistically significant.

Other findings from the multi-variate analysis were: (a) the clinics themselves had a significant effect on adherence, (b) patient characteristics (caretaker satisfaction, caretaker trust, family/household

size) did not appear to affect adherence, and (c) initial dosage (three or five days of pills) had a marginally significant effect on caretaker adherence. The following paragraphs summarize the multi-variate analyses that produced these findings.

The multi-variate analyses used pill ratio as the indicator of caretaker adherence (dependent variable). Table 9 summarizes the pill ratio and sample size by clinic, initial dosage, type of nurse, and study group.

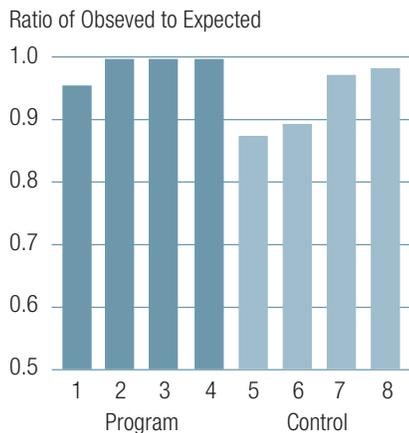
Figure 6 presents the mean pill ratio of each clinic graphically and can be used to explain the interaction among study group, type of nurse, and individual clinic. Clinics 1–4 are program and clinics 5–8 control; clinics 1,2, 5, and 6 have technical nurses; and clinics 3, 4, 7, and 8 have professional nurses. Clinic 1 (technical nurse) is the lowest among the program clinics, and clinics 5 and 6 (technical nurses) are lowest among the control clinics. A Tukey *post hoc* multiple comparison test (Stevens 1992) found that

Table 9
Mean Pill Ratios within Clinic, by Study Group, Type of Nurse, and Initial Dosage

	Program Clinics					Control Clinics				
	1	2	3	4	Pooled	1	2	3	4	Pooled
	Technical Nurse		Professional Nurse			Technical Nurse		Professional Nurse		
All cases (n = 671)										
Mean pill ratio	0.945	0.993	0.991	0.993	0.979	0.868	0.889	0.968	0.976	0.929
Sample size	94	98	77	77	346	78	73	91	83	325
By initial dosage (n = 642)										
1–3 days of pills:										
Mean pill ratio	0.949	0.990	1.000	0.993	0.979	0.874	0.950	0.968	0.982	0.925
Sample size	69	72	35	41	217	67	5	47	22	141
4–5 days of pills:										
Mean pill ratio	0.932	1.000	0.984	0.994	0.980	0.835	0.881	0.964	0.973	0.933
Sample size	25	24	42	35	126	11	48	40	59	158
By type of nurse (n = 642)										
Technical nurse:										
Mean pill ratio	0.944	0.993	—	—	0.969	0.869	0.888	—	—	0.876
Sample size	94	96	—	—	190	78	53	—	—	131
Professional nurse:										
Mean pill ratio	—	—	0.991	0.993	0.992	—	—	0.966	0.975	0.971
Sample size	—	—	77	76	153	—	—	87	81	168

Notes: (1) Mean pill ratio is the mean of all caretaker pill ratios in that sample. (2) The pooled mean pill ratio is mean pill ratio weighted by the sample size for all clinics in the group. (3) A ratio closer to 1 indicates greater adherence. (4) Twenty-nine (29) cases were excluded from the analysis of initial dosage as more than 5 days of pills were given at the first visit.

Figure 6
Mean Adherence to Cotrimoxazole by Clinic



the mean pill ratio for clinic 5 was significantly different from all other clinics, and the mean pill ratio for clinic 6 was significantly different from all other clinics except clinic 1, but the mean pill ratio for clinics 7 and 8 (control group professional nurses) were not significantly different from any of the four program clinics (ANOVA [7,663] $F = 12.509, p < .001$).

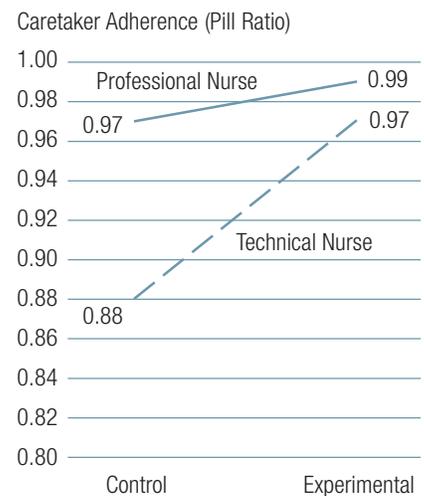
To assess the effect of the individual clinic on caretaker adherence, we used an analysis of variance (ANOVA) that treated clinics as nested in the two treatment levels (program and control) and crossed with the factor “days of medication received.” We found that the effect of the clinic had a greater impact on adherence than the job aids as only Clinic (nested in Study Group) was significant: $F(6,626) = 6.852, p < .01$. Study group was not significant. Number of days of treatment received at the initial visit was marginally significant: $F(1, 626) = 4.400, p = .052$. As seen in Table 9, caretaker adherence was lowest in the two control clinics staffed with

technical nurses who gave four to five days of pills at the first visit. We verified the effect of the clinic using hierarchical linear modeling (HLM), which examined the impact of the clinic and its attributes on the pill ratio data.

Since there was a significant effect of the clinic on caretaker adherence, we considered the characteristics of the nurses as possible predictors of adherence. In clinics 1, 2, 5 and 6, the health workers were technical nurses (two-year basic training): three of these clinics (1, 5, and 6) had the lowest adherence. The other health nurses were professional nurses (comprehensive three-year training; see Table 2).

To better understand the interaction between type of nurse and the use of job aids as such interaction affects caretaker adherence, we ran a multifactorial ANOVA on these factors. The results were clear: the interaction between the use of job aids and type of nurse was significant, as were the main effects for both study groups and type of nurse. Specifically, mean pill ratio in program clinics with technical nurses was 0.97 compared to only 0.88 in control clinics with technical

Figure 7
Caretaker Adherence by Type of Nurse and Study Group



Note: Adherence is measured as the ratio of consumed to expected pill count

nurses. Among professional nurses, adherence was 0.99 in the program clinics and 0.97 in the control clinics. Thus, the job aid program enabled the technical nurses to perform as well as the professional nurses without job aids and nearly as well as professional nurses with job aids (Table 10 and Figure 7).

Table 10
ANOVA Table for Effect of Study Group and Type of Nurse

Source	SS	df	MS	F	Signif.
Main Effects	1.189	3	.396	26.15	.001
Study Group	.514	1	.514	33.92	.001
Type of Nurse	.566	1	.566	37.36	.001
Interaction	.205	1	.205	13.50	.001
Residual	10.108	667	.015		

Notes: SS = sum of squares; df = degrees of freedom; MS = mean square ratio; F = F-value.

H. Overall Adherence

“Overall adherence” refers to the proportion of all caretakers who received a full five days of pills and who, on the day of the home visit had apparently given the child the correct number of doses, as indicated by the pill count. Of the 677 caretakers in both groups, we had information on 675 to calculate overall adherence: 347 in the

program group and 328 in the control. The program and control groups had overall adherence of 68 percent and 56 percent, respectively, a highly significant difference (chi-square = 10.15, $p = .001$) (Table 11). This compares to caretaker adherence (proportion adhering exactly) of 90 percent in the program and 76 percent in the control group. Hence, the ratio of overall adherence between the two study

groups is about the same as for caretaker adherence, but overall adherence is about 12–14 percentage points below caretaker adherence. This shortfall in the control clinics is an indicator of inadequate adherence by the nurses.

To determine the effect of initial dosage on overall adherence, we divided initial dosage into two categories: cases where the initial

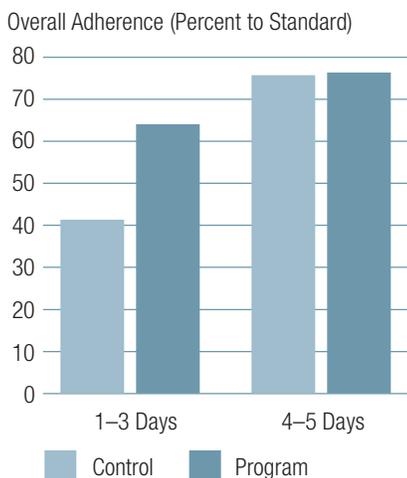
Table 11
Percentage with Overall Adherence within Study Site, by Initial Dosage and Study Group

	Program Clinics					Control Clinics					All Clinics Pooled
	1	2	3	4	Pooled	1	2	3	4	Pooled	
	Technical Nurse		Professional Nurse			Technical Nurse		Professional Nurse			
All cases (n = 675)											
Overall adherence, % yes	59.1	56.1	84.6	75.6	67.7	23.1	50.7	75.6	71.1	55.5	61.8
Fraction (# yes / total)	55/93	55/98	66/78	59/78	235/347	18/78	37/75	68/91	59/84	182/328	417/675
By initial dosage (n = 645) ⁽¹⁾											
1–3 days of pills:											
Overall adherence, % yes	63.8	50.0	85.7	65.9	63.1	23.9	20.0	65.2	45.5	40.7	54.3
Fraction (# yes / total)	44/69	36/72	30/35	27/41	137/217	16/67	1/5 ⁽¹⁾	30/46	10/22	57/140	194/357
4–5 days of pills:											
Overall adherence, % yes	45.8	70.8	83.7	88.9	75.6	18.2	57.1	85.4	80.0	74.9	75.2
Fraction (# yes / total)	11/24	17/24	36/43	32/36	96/127	2/11	28/49	35/41	48/60	113/161	209/288
P-value, ⁽²⁾ 4–5 vs. 1–3 days	< .001	.075	.808	.017	.017	.020	.113	.031	.002	< .001	< .001
By type of nurse (n = 675) ⁽³⁾											
Technical nurse:											
Overall adherence, % yes	59.1	55.2	—	—	57.6	23.1	49.3	—	—	35.9	48.6
Fraction (# yes / total)	55/93	55/98	—	—	110/191	18/78	37/75	—	—	55/153	165/344
Professional nurse:											
Overall adherence, % yes	—	—	84.6	76.6	80.1	—	—	75.6	71.1	72.6	76.1
Fraction (# yes / total)	—	—	66/78	59/78	125/156	—	—	68/91	59/84	127/175	252/331
P-value, ⁽²⁾ tech vs. prof					< .001					< .001	< .001

Notes: (1) Excludes 11 cases with missing initial dosage data and 19 cases at clinic 6 because caretakers received 7 days of pills at initial visit. (2) Chi-square test. (3) This analysis includes all cases. If the 19 overdosing cases are excluded, the results are essentially the same, with overall adherence at clinic 6 = 30/56 and the difference between technical and professional nurses still highly significant ($p < .001$).

dosage was one, two, or three days' worth of pills and cases where it was four or five. Most initial dosages were three (41 percent) or five (39 percent). Clinic 6 had 19 cases for which seven days of pills were given at the initial visit. We excluded these 19 cases from the analysis along with another 11 cases where information on initial dosage was missing: the result was 645. Overall adherence was clearly higher for initial dosage of four or five days' worth (75 percent) than one to three (54 percent) (Table 11, Figure 8). This difference was highly significant ($p < .001$). In the control clinics, overall adherence was much higher in the four- or five-day initial dosage group (63.1 percent) than in the one- to three-day group (40.7 percent), but in the program clinics there was essentially no difference between the two groups (75.6 percent and 74.9 percent). This suggests the program of health worker training and job aids can overcome inadequate initial dosing.

Figure 8
Effect of Initial Dosage and Study Group on Overall Adherence



We examined overall adherence by type of nurse with and without the 19 overdosing cases. The results were essentially identical. Once again, clinics 5 and 6 (technical nurses, control group without the benefit of job aids) had the lowest overall adherence. Professional nurses had significantly higher overall adherence than technical nurses in both the program and control clinics (Table 11).

VII. Discussion

Our finding was that the job aids and IPC training were effective in improving adherence to the regimen when used by technical nurses. We are confident of this finding for the clinics and nurses studied, but having only eight nurses in the study means that its generalizability is uncertain.

The QA Project's work on the design of job aids for health providers has been successful with other less-trained health workers in developing countries. The project developed a case management map (critical pathway) for use in Uganda for in-hospital treatment of pre-eclampsia. The map served as both a job aid to remind nursing and hospital staff of correct care and treatment of pre-eclampsia and as a medical record for documenting that care (Kierstens et al. Forthcoming). The project also developed a poster depicting the correct medication and dosage for malaria treatment for use in Kenya for private drug outlets. Owners of small kiosks that sell anti-malarials were given the poster by the drug wholesaler, resulting in improved use of the anti-malarials (Tavrow et al. 2002).

An unexpected finding during the study was that caretakers were not given the full five days of pills or age appropriate dosage at the initial visit. The explanation given for underdosing according to age was that the children were dosed according to their weight. Although we were unable to calculate this, as we did not collect those data, it seems unlikely that this alone could explain all the underdosing by age. We expect that the full five-day course was not given at the initial visit because: (a) there had been a recent nation-wide stock-out of cotrimoxazole shortly before the study, so clinic staff were conserving stocks, (b) health workers were concerned that pills would be wasted because caretakers would not give the full dosage to their children, and (c) health workers had misunderstood the national policy and believed that a child was to return for an exam after three days of treatment, at which time they would receive the last two days of treatment.

We consequently sponsored the purchase of cotrimoxazole for the eight study sites, and the Boboye District supervisor clarified national policy on the treatment of childhood pneumonia. We took this opportunity to examine whether adherence would differ when caretakers received four or five days of treatment at the initial visit compared to three days or less, and whether that effect differed by study group. The key finding of this analysis was that *overall* adherence was significantly higher when initial dosage was four or five days than when it was one to three days in both the program and control groups, with the difference being greater in clinics staffed by

technical nurses. As would be expected, *caretaker* adherence was actually slightly higher with a one- to three-day initial dosage than a four- or five-day initial dose, since following a regimen for up to three days is easier than following it for more. Without the benefit of job aids, a longer course of treatment resulted in poorer *caretaker* adherence, especially in clinics staffed by technical nurses.

A limitation of the study was the use of a pill count as a measure of caretaker adherence. Although pill count may overestimate adherence behavior, this may be counteracted if it is conducted unannounced in the patient's home (Farmer 1999). Visiting on the fourth or fifth day may also have biased the adherence estimates upwards for those receiving less than four days of pills. These caretakers may have given the last dose late, but before the pill count was performed. Although the control group was visited on average 4.6 days after the consultation compared to 4.2 days for the program group, an additional analysis using only fifth-day observations made little difference in the results.

The conceptual framework for the study (Figure 3) suggests further analyses of these data, particularly the association between maternal knowledge, trust in the health

worker, and satisfaction with the clinic visit and the outcome (adherence). Although not the main focus of this study, an understanding of the effects of these factors would be useful in determining antecedents to adherence in this population.

A regression analysis is not appropriate because it assumes that there is no clinic or clinic worker effect, which we have shown is not the case with these data. The small number of clinics in our sample precluded an analysis of clinic effects. The HLM analysis requires a minimum sample size of 10 for each level-2 variable, and our sample of eight facilities restricted the analysis to one level-2 variable.

VIII. Conclusions and Recommendations

We have shown that caretaker adherence and overall adherence were improved when less-trained technical nurses used job aids designed for themselves and their clients. The job aids enabled technical nurses to perform as well as professional nurses without job aids. The study also found that a longer course of initial treatment (five days rather than three) resulted in better overall adherence in control clinics, but there was no difference in program clinics.

If the job aid program can achieve similar results with other technical nurses in Niger, serious consideration should be given to its replication throughout the country. In order to determine if it is replicable, further testing of its effects should be carried out in other clinics. At the same time, cost estimates should be made.

Our results clearly support the national policy of giving the full course of cotrimoxazole at the time of the initial visit. Distribution of these results to health workers may provide an incentive to adhere to the national policy when possible. Furthermore, the magnitude of the positive effect of giving the complete course of pills at the initial visit may justify increased attention and resources to maintain adequate inventories of cotrimoxazole at the clinics.

Our experience in this study has practical implications for programs designing or using job aids. The job aids and IPC training significantly improved technical nurses' performance, so this type of nurse should be included in programs that design, test, and/or implement job aids for use by this type of nurse. Less highly trained health workers seem to benefit the most from using job aids, resulting in better outcomes for their patients.

IX. Recommendations from Niger Workshop

The study findings were presented in a workshop in Niger where participants developed the following recommendations:

1. Assure the availability of cotrimoxazole in pediatric dosages (120 mg)
2. Reinforce national IMCI policy of giving all medication at initial visit
3. Ensure that educational materials and posters are available for everyone, especially technical nurses
4. Accelerate implementing the IMCI community component
5. Integrate the job aid counseling card and poster into the national IMCI training
6. Study the possibility of integrating the job aid envelopes into the cost-recovery system (if cost is 3–8 CFA each)
7. Expand the study to other regions and another cultural group in Niger
8. Study the effect of including men in the care of sick infants
9. Study children referred to other facilities to examine pneumonia case management
10. Assess long-term impact of job aids in the community
11. Advocate for financial partners

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nurses belonged to one of two types: technical nurses had two years of basic training, and professional nurses had three years of comprehensive training. Analysis of variance (ANOVA) revealed that, in clinics staffed by technical nurses, caretaker adherence was significantly higher in program clinics than in control clinics. Although the professional nurses achieved better adherence than technical nurses, caretaker adherence was not much higher for professional nurses in program clinics than in control clinics.

The clinics themselves also had a significant effect on caretaker adherence. Client characteristics such as caretaker satisfaction, caretaker trust, and household size were not related to adherence. Partway into the study, we learned that the clinics were giving only one to three days of pills at the initial visit, urging caretakers to return

in a few days for the balance. This led to a mid-study correction where all clinics were instructed to give the full course at the initial visit. We took this midcourse redirection as an opportunity to investigate the effect of the initial dosage on adherence: overall adherence was 20 percentage points higher among caretakers given the full course at the initial visit than caretakers given less.

Several indicators of household practice and child health improvements were higher in the program than in the control group, while no difference was observed in caretakers' knowledge between the two study groups. All four nurses in the control group were consistently better at counseling after they received training and the job aids than they were beforehand, while nurses in the post-training program group were superior to the pre-training control group nurses in only certain counseling behaviors.

This study showed that a set of job aids for the health worker and the caretaker can enable less highly trained nurses to achieve very high caretaker adherence to cotrimoxazole: nearly equal to that of more highly trained nurses. This improvement is expected to result in better outcomes for their patients. This study also showed that the national policy of giving caretakers the complete course at the initial visit is justified. A practical implication of this experience is that technical nurses in Niger should be involved in the design and pre-testing of job aids and trained in their use. Finally, the study highlights the many factors that reduce adherence and calls for further research to determine which of those factors could reasonably be reduced or eliminated in developing country settings to restore children's health and reduce AMR.